ORIGINAL RESEARCH

International Journal of Surgery 12 (2014) 320–324

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.journal-surgery.net

Original research

The implementation and effectiveness of an enhanced recovery programme after oesophago-gastrectomy: A prospective cohort study

S.J. Ford, D. Adams, S. Dudnikov, P. Peyser, J. Rahamim, T.J. Wheatley, R.G. Berrisford, G. Sanders*

Peninsula Oesophago-Gastric Surgery Unit, Level 7 Derriford Hospital, Plymouth PL6 8DH, Devon, UK

ARTICLE INFO

Article history:
Received 4 September 2013
Received in revised form
26 September 2013
Accepted 21 January 2014
Available online 31 January 2014

Keywords:
Enhanced recovery
Oesophagectomy

ABSTRACT

Background: Oesophageal resection is notoriously complicated and produces a cohort of patients prone to postoperative complications. Maintaining quality care demands a systematic approach to patient management yet postoperative recovery after oesophagectomy is often needlessly inefficient, heterogeneous and governed by the idiosyncrasies of the operating surgeon. Enhanced recovery after surgery (ERAS) programmes are now well established in colorectal surgery and here we describe the implementation and effectiveness of an ERAS programme for the postoperative management of Ivor Lewis oesophago-gastrectomy (ILOG).

Methods: An ERAS programme was devised and implemented with the support of a dedicated in-hospital task-force. Three consultant surgeons allocated consecutive patients to the programme (ERAS) and outcomes were compared to consecutive patients not on the ERAS programme (non-ERAS) and a pre-ERAS cohort (pre-ERAS). Principal outcome measures were total length of stay (TLOS), Accordion postoperative complication grade and 30-day readmission rate.

Results: 75 patients were enrolled on the ERAS programme, 41 continued as a non-ERAS cohort and 80 consecutive pre-ERAS patients were identified. A significant improvement in median TLOS was observed in the ERAS group (10 days r.7–58) compared to pre-ERAS (13 days r. 8–57) ($p = <0.001$) and non-ERAS patients (13 days r.8–42) ($p = <0.001$). No significant difference in Accordion scores for postoperative complications or 30-day readmission rates were observed.

Discussion: The introduction of an ERAS programme after ILOG can significantly reduce TLOS without jeopardising patient safety or clinical outcomes. The successful introduction of an ERAS programme requires full motivation and support from all team members including the patient.

1. Introduction

The evolution of high-volume centres for oesophago-gastric surgery has created an environment capable of supporting the dedicated infrastructure and breadth of multi-disciplinary experience required to deliver consistently high quality outcomes [1,2]. Oesophageal resection is notoriously complicated and produces a cohort of patients particularly prone to peri-operative morbidity and mortality [3,4]. Maintaining quality care demands a comprehensive and systematic approach to patient management with the formulation of standardised clinical care pathways [5,6]. Such pathways optimise every aspect of patient care from initial referral through to postoperative follow-up, improving outcomes and reducing costs [5,6]. However, the immediate postoperative recovery phase after major oesophageal resection often remains faithful to the idiosyncrasies of the individual operating surgeon leading to inefficient patient progression and needlessly prolonged inpatient stay. Enhanced recovery after surgery (ERAS) programmes are now well established in colorectal surgery, driven by a multi-disciplinary approach that aims to ally the expectations of surgeons, nursing staff, physiotherapists, dieticians and most importantly the patient, to facilitate an accelerated and safe hospital discharge [7,8]. Considering that published series report an inpatient post-oesophagectomy stay of between 11 and 26 days [3,5,9,10] and that the potential benefits of ERAS programmes have been clearly demonstrated in other cancer care pathways, we wish to focus attention to replicate this success in major oesophago-gastric resections.

Here we describe the implementation and effectiveness of a goal-directed ERAS programme for the postoperative management

* Corresponding author. Tel.: +44 01752 202082.
E-mail address: gsanders@nhs.net (G. Sanders).

1743-9191/$ – see front matter
http://dx.doi.org/10.1016/j.ijsu.2014.01.015

Table 1
Enhanced recovery after surgery programme for ILOG patients implemented at the Peninsula Oesophago-Gastric Surgery Unit, Derriford Hospital, October 2011.

	Day of Operation (Day 0)	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Monitoring	Hourly observations Heart monitor attached Humidified oxygen via mask TED stockings in situ	2–4 hourly obs Hourly urine Remove heart monitor TEDS – removed, legs checked, replaced daily	4–6 hourly obs Hourly urine			Stop Oxygen	6 hourly obs	6 hourly obs
Pain Control	Epidural, PCA or Paravertebral IV paracetamol Diclofenac PR if required					Remove epidural / paravertebral Oral analgesia		
Exercise	Supported to lie upright in bed Sit out in chair (depend time get to ward) Leg movements in bed Breathing exercises using incentive spirometer	Sit out in chair Support patient to mobilise x4 times per day Other exercise as per Day 0						
NG Tube	In place				Spigot (4–6 hrly aspirates)	Consider removal		
Chest Drains	In place					Consider removal 1 chest drain	Consider removal 2nd & 3rd (left sided) if present	
Abdominal Drain	In place			Consider removal				
Urinary Catheter	In place			Consider removal				
Central Line	In place			Consider removal				
IV Fluids	In place				Consider stopping			
Eating and Drinking	jejunostomy feed 30ml/hr Sips of water up to 100ml per hour				Free Fluids		Start full diet as per dietician advice. Overnight feed via jejunostomy	Dietitian review as to need for overnight jejunostomy feeding at home
Wound Care		Change drain dressings Surgical wounds checked & dressings changed if necessary				Leave surgical wound undressed, if dry and healing well		
Investigations	Chest X-Ray recovery	Chest X-Ray		Chest X-Ray		Chest X-Ray	Chest X-Ray	Chest X-Ray
		FBC, U&E	FBC, U&E	FBC, U&E, CRP	FBC, U&E	FBC, U&E, CRP	FBC, U&E	

of two-stage Ivor Lewis oesophago-gastrectomy (ILOG) patients in a high-volume regional tertiary referral centre for oesophago-gastric resections.

2. Methods

An ERAS programme was devised to standardise the admission process and postoperative management of oesophagectomy patients with a principle aim of reducing inpatient stay whilst maintaining or improving outcomes. The ERAS programme was designed over a series of meetings involving a task-force of representatives from all aspects of patient care, principally oesophago-gastric surgeons, specialist anaesthetists, cancer specialist nurses, theatre staff, dieticians, physiotherapists, senior nursing staff, directorate managers and a Trust appointee for the implementation of ERAS programmes. The finalised ERAS programme (adapted with

Table 2
Accordion Severity Grading System (ASGS) for postoperative complications [11].

Severity Grade	
1 Mild complication	Requires only minor invasive procedures at the bedside
2 Moderate complication	Requires pharmacological treatment such as antibiotics
3 Moderate complication	Requires management by endoscopic intervention or intervention without anaesthesia
4 Severe complication	Requires management by a procedure under general anaesthesia
5 Severe complication	Organ system failure
6 Death	Postoperative death within 30 days

The ASGS provides a framework for complication assessment which is based on grading the complexity of therapy for the complication.

Table 3
Median total length of stay and length of stay for pre-ERAS, ERAS and non-ERAS groups.

	Number of patients	Total length of stay (days)	Postoperative length of stay (days)
Pre-ERAS	80	13 r.8–57 ($P = <0.001$)	12 r.7–56 ($P = <0.001$)
ERAS	75	10 r.7–58	10 r.7–58
Non-ERAS	41	13 r.8–42 ($P = <0.001$)	12 r.8–41 ($P = 0.002$)

All comparisons made to ERAS group.

Table 4
Accordion Severity Grading System (ASGS) for postoperative complications and anastomotic leak rate by group.

ASGS score	ERAS (75)	Non-ERAS (41)	Pre-ERAS (80)
0	27 (36%)	20 (48%) $p = 0.3$	38 (48%) $p = 0.26$
1–3	37 (49%)	12 (29%) $p = 0.11$	25 (31%) $p = 0.07$
4–5	11 (15%)	9 (22%) $p = 0.6$	16 (20%) $p = 0.42$
6	0 (0%)	0 (0%)	1 (1.3%) $p = 0.33$
Anastomotic leak	3 (4%)	2 (5%)	11 (14%) $p = 0.05$

All comparisons made to ERAS group.

permission from Virginia Mason Medical Centre, Seattle) was designed to be a standardised pathway independent of which weekday the operation occurred upon. Crucially all patients were informed of the process before admission and encouraged to document and take ownership of their progress. Preoperative assessment was centralised to facilitate admission on the day of surgery. The ERAS programme (Table 1) was introduced in October 2011 with three consultant oesophago-gastric surgeons allocating consecutive patients to the ERAS programme and two surgeons continuing with their established postoperative instruction. Thus for analysis, three patient groups exist: consecutive patients prior to the introduction of the ERAS programme (pre-ERAS) (July 2010–September 2011); consecutive patients enrolled on the ERAS programme (ERAS) (October 2011–July 2013) and patients not enrolled on the ERAS programme but treated during this time-frame (non-ERAS) (October 2011–July 2013). All patients undergoing two-stage open or laparoscopically assisted ILOG were included in the study.

Independent variables included for analysis were: treatment group, patient age, total length of hospital stay (TLOS), postoperative length of stay, operative abdominal approach, Accordion Severity Grading System (ASGS) for postoperative complications [11] (Table 2), radiologically confirmed anastomotic leak and 30-day re-admission rate.

Continuous data were analysed using the Mann–Whitney *U* test and dichotomous data were compared using X^2 and Fisher's exact test. All *P* values reported were two-tailed and $P < 0.05$ was considered to be statistically significant. SPSS® version 18 (IBM, Armonk, New York, USA) and Baseline 100 (SAA Software, UK) were used for statistical analysis.

3. Results

The ERAS task-force identified multiple areas for improving and streamlining the care pathway from preoperative assessment to recovery. Day of surgery admission was introduced, with patients having been pre-assessed and engaged in a brief educational session regarding the ERAS programme and anticipated goals. Oral sips of water (maximum 100 ml/h) were initiated from the day of surgery. Routine contrast swallow radiology was removed (previously performed on postoperative day 4–6 depending on timing of the weekend). Incentive spirometry, early drain removal and modified dietary goals were also introduced (Table 1). A policy of immediate extubation and postoperative management in a dedicated monitored ward bed with a paravertebral block for laparoscopically assisted ILOG or a thoracic epidural for open abdominal procedures had already been established prior to the introduction of the ERAS programme.

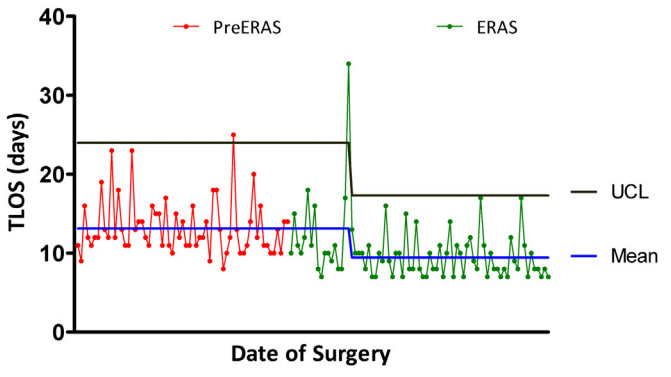

Fig. 1. Statistical process control chart illustrating total length of stay over time before and after the introduction of ERAS.

Eighty consecutive patients were studied in the pre-ERAS group, 75 patients were enrolled on the ERAS programme and 41 continued as the non-ERAS group over a 21-month period. Data was available for all patients and none were excluded. No difference in median age was noted between the pre-ERAS, ERAS and non-ERAS groups: 68 (range 44–82), 67 (range 34–86) and 66 (range 31–84) years respectively.

The abdominal phase of the ILOG was different between the groups with significantly more patients in the ERAS group having a laparoscopically assisted abdominal phase: number of laparoscopically assisted procedures; ERAS 58 (77%) *versus* pre-ERAS 38 (48%) and none in the non-ERAS group ($P = <0.001$ and $P = <0.001$ respectively).

Significant improvements in TLOS and postoperative length of stay were observed with the introduction of the ERAS programme (Table 3). Median TLOS in the pre-ERAS group was 13 days (range 8–57) compared to just 10 days (range 7–58) for those following the ERAS programme ($P = <0.001$). Median TLOS for the non-ERAS group was 13 days (range 8–42), significantly longer than the ERAS group ($P = <0.001$). A significant reduction in postoperative length of stay was recorded with the introduction of the ERAS programme with a median postoperative length of stay in the ERAS group of 10 days (range 7–58) compared to 12 for the pre-ERAS group (range 7–56) ($P = <0.001$) and 12 days for the non-ERAS group (range 8–41) ($P = 0.002$).

A statistical process control chart (Fig. 1) for pre-ERAS and ERAS group TLOS (ASGS $\geq$ 4 excluded) demonstrated a progressive and stable fall in TLOS with the introduction of ERAS.

The operative approach to the abdominal phase of the ILOG (open or laparoscopically assisted) did not significantly influence TLOS in either the pre-ERAS or ERAS groups.

The ASGS score for postoperative complications was broken down into no complications (score 0), mild to moderate complications (score 1–3), severe complications (score 4–5) and postoperative death (score 6). No significant increase or decrease in postoperative complications was recorded with the introduction of ERAS compared to the pre-ERAS era or non-ERAS patients (Table 4). 1 postoperative death occurred in the pre-ERAS group. The ERAS group suffered significantly fewer radiologically confirmed anastomotic leaks than the pre-ERAS group: 3 (4%) *versus* 11 (14%) respectively $P = 0.05$. No difference in the incidence of leak rate was observed between the ERAS and non-ERAS groups: 3 (4%) and 2 (5%) respectively.

No significant differences in 30-day re-admission rates were recorded between the groups with 10 patients (13%) re-admitted from the ERAS group compared to 10 patients (11%) before the introduction of the ERAS programme and 3 patients (7%) in the non-ERAS group.

4. Discussion

The current era of severe financial constraint and ever increasing demand for healthcare is a potent evolutionary driver for the efficient use of resources whilst maintaining or improving clinical standards. Upper gastrointestinal cancer services have been centralised to create regional high volume centres in the pursuit of improved outcomes [2]. However, even after minimally invasive oesophagectomy, the reported median length of stay is 15 days in the UK [12] and is highly variable [3,9]. The multidisciplinary approach to cancer staging, patient selection and choice of procedure lends itself to the introduction of standardised clinical care pathways with attendant improvements in patient care [13,14]. However, despite the clear benefits of ERAS programmes, now enshrined in the management of colorectal resections [8], the postoperative management of oesophagectomy patients remains highly idiosyncratic and variable. Nonetheless, a small number of reports describing a success reduction in postoperative stay after oesophagectomy, often as part of a wider standardised clinical pathway or involving limited numbers of patients have been published [6,13,15].

The design, evolution and implementation of an ERAS programme requires considerable dedication and crucially consultation with key stakeholders and representatives from all disciplines involved in patient care. Departure from historical perceptions of the postoperative management of oesophagectomy patients is integral to enhanced recovery and goal directed daily targets, with patient co-operation, are essential to prevent “drift” from the programme. However, inevitably postoperative complications occur that necessitate temporary deviation from the ERAS programme. The success of an ERAS programme is multi-factorial. Some of the key changes introduced within the ERAS programme were the introduction of day of surgery admission, the institution of oral water intake immediately after the operation, elimination of a routine contrast study and timely drain removal. Prior experience of immediate extubation, transfer to a dedicated monitored ward bed and early mobilisation coupled with regional anaesthesia techniques undoubtedly facilitated the application of ERAS and helped create the appropriate patient mind-set. Paravertebral blocks avoid the potential hypotensive sequelae associated with thoracic epidurals that can delay early mobilisation and complicate postoperative fluid balance [16]. Patient admission on the morning of surgery eliminated an unnecessary night in hospital and avoided the anxiety of waiting for bed availability and ward based preoperative assessment.

The ERAS programme is now firmly established in our institution with 75 consecutive patients successfully enrolled over a 21-month period. The ERAS programme reduced the median total length of stay by 3 days compared to pre-ERAS patients, equating to a considerable cost saving and reduction in resource allocation. The fall in TLOS observed after the introduction of ERAS became increasingly stable with reduced variation when plotted on a statistical process control chart (Fig. 1). The lack of change in TLOS and length of stay, observed in the non-ERAS group compared to pre-ERAS patients, strongly supports the conclusion that the reduced length of stay in the ERAS group is attributable to the introduction of the ERAS programme rather than simply a function of the time period studied.

The ERAS programme was safely introduced with no impact on 30-day readmission, postoperative morbidity or mortality rates compared to pre-ERAS and non-ERAS patients. Patients following the ERAS programme had a significantly lower rate of anastomotic leak than the pre-ERAS group. However, the small number of patients involved, lack of difference in leak rate between the ERAS and non-ERAS groups and the removal of routine postoperative contrast studies, as part of the ERAS programme, prevents interpretation of the possible influence of the ERAS programme on leak rate.

One of the perceived potential benefits of a laparoscopically assisted ILOG is the reduction in length of hospital stay due to a more rapid recovery [17,18]. The percentage of patients enrolled on the ERAS programme undergoing a laparoscopic abdominal approach was significantly higher than either the pre-ERAS or non-ERAS cohorts. The initial impression may therefore be that any reduction in TLOS in the ERAS cohort is simply a reflection of a more minimally invasive procedure. However, within the ERAS group, those receiving a laparoscopically assisted ILOG demonstrated no difference in median TLOS suggesting that within the context of an ERAS programme, any potential benefit from minimally invasive surgery on reduced length of stay may be lost.

The introduction of an ERAS programme after ILOG can significantly reduce the length of inpatient recovery without jeopardising patient safety or clinical outcomes. The design, implementation, evaluation and revision of a successful ERAS programme requires the involvement and dedication of all disciplines concerned with patient care. An ERAS programme must blend seamlessly with optimised peri-operative patient management and requires the full motivation of all team members and the patient.

Ethical approval

Not relevant.

Funding

None.

Author contribution

SJ Ford – data collection, data analysis and writing.
D Adams – study design.
S Dudnikov – study design.
P Peyser – study design.
J Rahamim – study design.
T Wheatley – study design and writing.
RG Berrisford – study design, data collection and analysis.
G Sanders – study design, data analysis and writing.

Conflicts of interest

No conflicts of interest declared.

References

[1] O. Anderson, et al., Hospital volume and survival in oesophagectomy and gastrectomy for cancer, Eur. J. Cancer 47 (2011) 2408–2414.
[2] S.R. Markar, A. Karthikesalingam, S. Thrumurthy, D.E. Low, Volume-outcome relationship in surgery for esophageal malignancy: systematic review and meta-analysis 2000–2011, J. Gastrointest. Surg. 16 (2012) 1055–1063.
[3] S.M. Griffin, I.H. Shaw, S.M. Dresner, Early complications after Ivor Lewis subtotal esophagectomy with two-field lymphadenectomy: risk factors and management, J. Am. Coll. Surg. 194 (2002) 285–297.
[4] B.P. Whooley, S. Law, S.C. Murthy, A. Alexandrou, J. Wong, Analysis of reduced death and complication rates after esophageal resection, Ann. Surg. 233 (2001) 338–344.
[5] R.J. Cerfolio, A.S. Bryant, C.S. Bass, J.R. Alexander, A.A. Bartolucci, Fast tracking after Ivor Lewis esophagogastrectomy, Chest 126 (2004) 1187–1194.
[6] S.R. Preston, et al., Impact of a multidisciplinary standardized clinical pathway on perioperative outcomes in patients with oesophageal cancer, Br. J. Surg. 100 (2013) 105–112.

[7] J.K. Lovely, et al., Case-matched series of enhanced versus standard recovery pathway in minimally invasive colorectal surgery, Br. J. Surg. 99 (2012) 120–126.
[8] W.R. Spanjersberg, J. Reurings, F. Keus, C.J. van Laarhoven, Fast track surgery versus conventional recovery strategies for colorectal surgery, Cochrane Database Syst. Rev. (2011) CD007635.
[9] W. Hofstetter, et al., Treatment outcomes of resected esophageal cancer, Ann. Surg. 236 (2002) 376–384.
[10] R.C. Karl, R. Schreiber, D. Boulware, S. Baker, D. Coppola, Factors affecting morbidity, mortality, and survival in patients undergoing Ivor Lewis esophagogastrectomy, Ann. Surg. 231 (2000) 635–643.
[11] M.R. Porembka, B.L. Hall, M. Hirbe, S.M. Strasberg, Quantitative weighting of postoperative complications based on the accordion severity grading system: demonstration of potential impact using the american college of surgeons national surgical quality improvement program, J. Am. Coll. Surg. 210 (2010) 286–298.
[12] R. Mamidanna, A. Bottle, P. Aylin, O. Faiz, G.B. Hanna, Short-term outcomes following open versus minimally invasive esophagectomy for cancer in England: a population-based national study, Ann. Surg. 255 (2012) 197–203.
[13] V. Munitiz, et al., Effectiveness of a written clinical pathway for enhanced recovery after transthoracic (Ivor Lewis) oesophagectomy, Br. J. Surg. 97 (2010) 714–718.
[14] D.E. Low, et al., Esophagectomy–it's not just about mortality anymore: standardized perioperative clinical pathways improve outcomes in patients with esophageal cancer, J. Gastrointest. Surg. 11 (2007) 1395–1402.
[15] C. Li, et al., An enhanced recovery pathway decreases duration of stay after esophagectomy, Surgery 152 (2012) 606–614.
[16] K. Holte, et al., Epidural anesthesia, hypotension, and changes in intravascular volume, Anesthesiology 100 (2004) 281–286.
[17] L. Bailey, et al., Open and laparoscopically assisted oesophagectomy: a prospective comparative study, Eur. J. Cardiothorac. Surg. 43 (2013) 268–273.
[18] S.S. Biere, M.A. Cuesta, D.L. van der Peet, Minimally invasive versus open esophagectomy for cancer: a systematic review and meta-analysis, Minerva Chir. 64 (2009) 121–133.